Space Weather Technical Forecast

Issued on Wednesday, 27 September 2023 at 13:06 Local

This technical forecast provides a four day assessment of space weather events. The probabilities stated below are for reaching or exceeding the given levels. For more information about space weather impacts please see the Met Office Space Weather Scales https://www.metoffice.gov.uk/weather/learn-about/space-weather/uk-scales

Space Weather Forecast Headline: Chance of M-flares (R1-R2 Radio blackouts) throughout. A diminishing slight chance of G1 minor geomagnetic storms at first Day 1 (27 Sep).

Analysis of Space Weather Activity over past 24 hours

Solar Activity: Solar activity has been Low. The largest flare was a C4.7 flare at 27/0546UTC originating from a region just beyond the southeast limb. There remains an ongoing chance of M-flares, with a slight chance of an X-flare.

There are currently seven sunspot regions on the visible disc, with five of these located in the western hemisphere. AR3445 in the southwest quadrant is a moderately large bipolar region, and has been the most active region in the past 24 hours. However, only small changes in evolution have been observed in recent imagery, with some growth in penumbra. AR3435 and AR3447 remain moderately large bipolar regions, with AR3447 developing a small delta spot in its intermediate portion. AR3435 has shown some decay in its trailing spots. The relatively new spot AR3449 in the northeast has shown further minor spot emergence. Remaining regions are generally simple and unremarkable.

No potential Earth-directed CMEs have been observed in the past 24hrs.

Solar Wind / Geomagnetic Activity: Solar winds have been at slightly elevated to elevated levels, in the range 450-530 km/s. Winds rose to peak in the first half of the period, before reducing gradually after midnight UTC. This increase may have been the result of some connection to CH50/-. Density was mostly average with a few peaks just above average. The Interplanetary magnetic field (IMF), Bt, was weak between 3-8nT. The north-south component (Bz) ranged from +6nT to -5nT but was often negative. Phi angle began positive (away from the Sun) but switched to negative (toward the Sun) from around 26/1400 UTC, returning to positive between 27/0400-0930UTC. Resultant geomagnetic activity started at G1/Minor Storm (Kp 5) levels, then became Unsettled to Active (Kp 3-4) from 26/1500UTC before subsiding to Quiet (Kp 1-2) on the most recent observations.

Energetic Particles / Solar Radiation: GOES16 high energy (greater than 10MeV) proton flux was at background levels. GOES16 high energy (greater than 2MeV) electron flux was at mainly moderate levels, with a peak of 766 pfu at 26/1605UTC. Associated 24-hour fluence was well below the Active (1e8 integrated pfu) threshold, but with a steady rising trend. The observation at 27/0001 UTC was 1.11e7 integrated pfu.

Four-Day Space Weather Forecast Summary

Solar Activity: Solar activity is forecast to be generally Low, but with a chance of M-class flares, and a slight chance of isolated X-class flares, most likely from the larger sunspot regions in the western hemisphere.

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Solar Wind / Geomagnetic Activity: A possible glance from weak CME arrivals cannot be ruled out at first on Day 1 (27 Sep), however this is deemed very low confidence.
Solar winds are expected to start at slightly elevated levels at first, most likely as a result of a waning influence of the CH50/- high speed stream. Solar winds are expected to gradually drop back to more ambient levels with no other obvious coronal holes predicted in the forecast period.
Geomagnetic activity is expected to be largely be Quiet to Unsettled (Kp 2-3), with a slight chance of Active or G1/Minor Storm (Kp 5) intervals at first on Day 1 (27 Sep) due to any possible further glancing CME effects. Quiet to Unsettled (Kp 1-3) activity is then expected to dominate from later Day 1 (27 Sep) through the rest of the period. However, a further enhancement is possible during Day 2 (28 Sep) with another potential glancing CME, but this is very low confidence.

Energetic Particles / Solar Radiation: High energy (greater than 10 MeV) proton flux is expected to remain at Background levels, with a daily slight chance of an enhancement should any larger flares occur.

High energy electron flux (greater than 2MeV) is likely to see moderate to high diurnal peaks through much of the period. The associated 24 hour fluence continues to rise but will most likely remain below the Active threshold.

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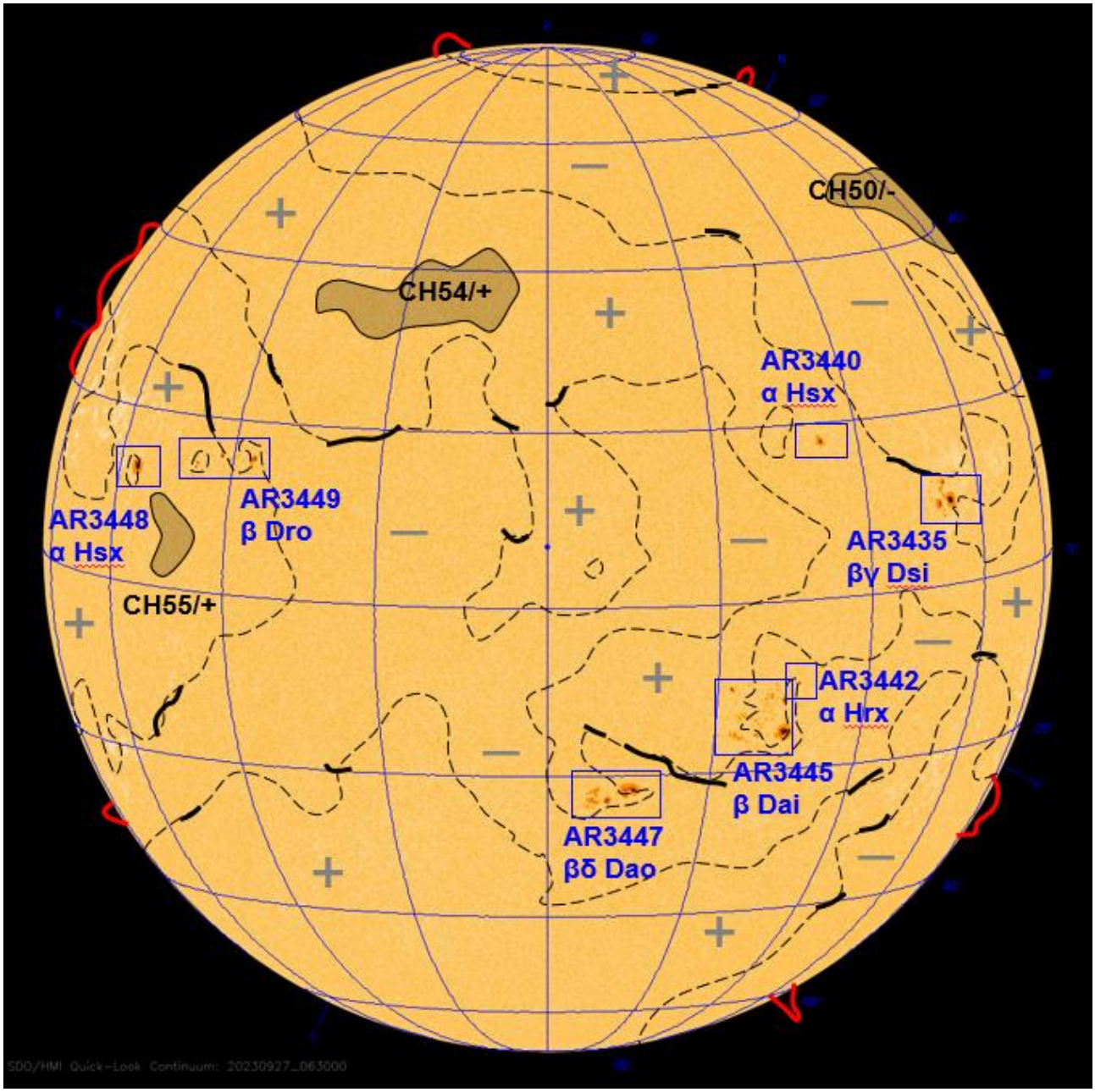
Figure 1. Solar Analysis Valid 27/0700UTC.



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Key: Filament ___ , Prominence ___ , Magnetic Field Line - - - , Polarity +/-, Coronal Holes: Grey shaded area CHxx +/-, Sunspot groups 25xx - Mt Wilson α-β-βγ-βγδ and Zurich-McIntosh Axx etc.

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Geomagnetic Storms:

There have been a number of CMEs that have left the Sun in the past week, but only one has had an impact at Earth. This CME was associated with the long period M1.2 flare from 22/0336 UTC, and arrived late on 24 Sep. The effects of the CME have since waned. There remains the potential for arrivals from two further CMEs from early on 22 Sep. The first from south of the AR3435/38 complex spot, and a further one to the north of this region. These are both weak eruptions but may give a slight chance of further enhancements at first on Day 1 (27 Sep) but this is very low confidence. Other CMEs that lifted off the Sun on 22 Sep are expected to be missing Earth but may give slight glancing impacts, potentially combined within the material in the aforementioned CMEs. The greatest likelihood is that any CMEs that left the Sun on 22 Sep have all either missed the Earth, or were caught up and combined with the one CME arrival that we did see.

Further CMEs were observed leaving the Sun from the western limb on 24/25 Sep. Most are far-sided, with a suggestion one could give a weak glancing blow on Day 2 (Sep 28), but this is deemed unlikely and treated as very low confidence.

Solar winds are expected to start at slightly elevated levels at first, most likely as a result of a waning influence of the CH50/- high speed stream. Solar winds are expected to gradually drop back to more ambient levels with no other obvious coronal holes predicted in the forecast period.

Overall this gives a slightly reduced confidence in the geomagnetic forecast. Geomagnetic activity is expected to be largely be Quiet to Unsettled (Kp 2-3), with a slight chance of Active or G1/Minor Storm (Kp 5) intervals at first on Day 1 (27 Sep) due to any possible further glancing CME effects. Quiet to Unsettled (Kp 1-3) activity is then expected to dominate from later Day 1 (27 Sep) through the rest of the period. However, a further enhancement is possible during Day 2 (28 Sep) with another potential glancing CME, but this is very low confidence.

Geo-Magnetic Storm	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability (Exceedance)			(%)	(%)	(%)	(%)
Minor or Moderate	G1 to G2	Yes	15	15	5	1
Strong	G3	No	1	1	1	1
Severe	G4	No	1	1	1	1
Extreme	G5	No	1	1	1	1

Geomagnetic Activity - Earthbound Coronal Mass Ejections

Date/time 21.5R (UTC)	Halo: Full or Partial	Source	Source Location	Estimated Speed	Estimated Arrival Time	Comments
22/1134	Partial	Filament	NW	592 km/s	Early 27 Sep	Missing/glancing
22/1504	Partial	Filament	SW	497 km/s	Early 27 Sep	Missing/glancing

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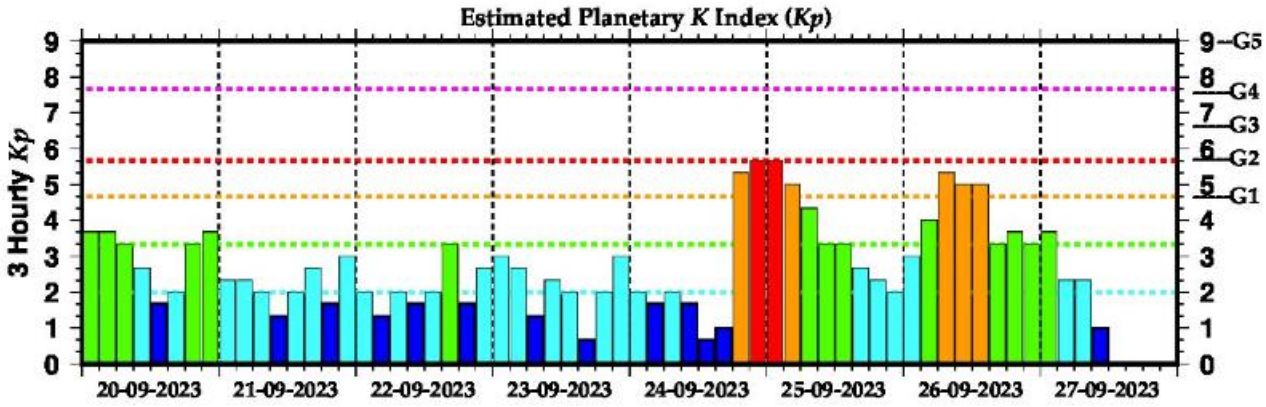
Figure 2: BGS plot of geomagnetic activity over the past 7 days.



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Met Office Space Weather Technical Forecast

Radio Blackouts - X-Ray Flares:

Solar activity has been Low. The largest flare was a C4.7 flare at 27/0546UTC originating from a region just beyond the southeast limb. There remains an ongoing chance of M-flares, with a slight chance of an X-flare.

There are currently seven sunspot regions on the visible disc, with five of these located in the western hemisphere. AR3445 in the southwest quadrant is a moderately large bipolar region, and has been the most active region in the past 24 hours. However, only small changes in evolution have been observed in recent imagery, with some growth in penumbra. AR3435 and AR3447 remain moderately large bipolar regions, with AR3447 developing a small delta spot in its intermediate portion. AR3435 has shown some decay in its trailing spots. The relatively new spot AR3449 in the northeast has shown further minor spot emergence. Remaining regions are generally simple and unremarkable.

Solar imagery and far sided seismic data also indicated there could be an active region just beyond the southeast limb which may rotate onto the visible disc in the coming days.

X Ray Flares	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability			(%)	(%)	(%)	(%)
Active	R1-R2 M Class	No	40	40	40	40
Very Active	R3 to R5 X Class	No	10	10	10	10

Solar Radiation Storms - (High Energy Protons):

The high energy (greater than 10MeV) proton flux observed by GOES16 is likely to persist at background levels, however with five active regions moving across the western disc there is a slight chance that any significant flares could produce an S1 or greater event. The most likely source regions would be AR3435, AR3445 and AR3447.

Radiation Storms	Level (cm^{-2} sr^{-1} s^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability (Exceedance)			(%)	(%)	(%)	(%)
Active	≥ S1	No	15	15	15	15
Very Active	≥ S3 *	No	1	1	1	1
* S3 ≥ 10 MeV ≥ 1000 pfu and / or ≥ 50 MeV ≥ 10 pfu. (pfu = $cm^{-2}sr^{-1}s^{-1}$)						

High Energy Electrons Event (≥ 2MeV):

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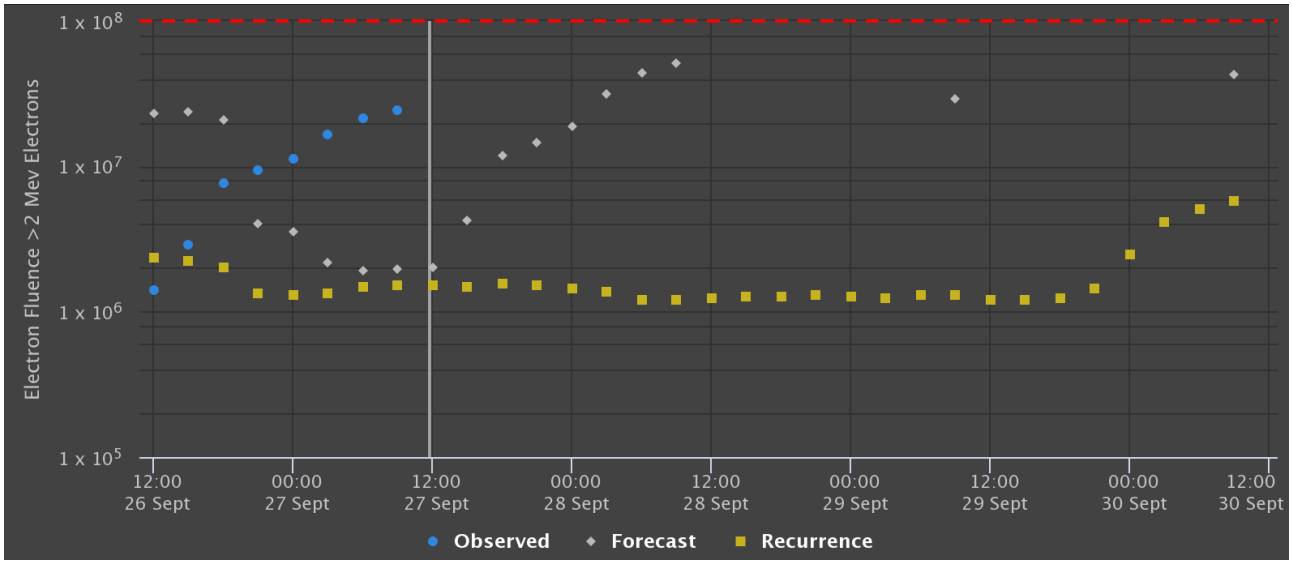
High energy electron flux (greater than 2MeV) observed by GOES16 has seen a rise to moderate levels. Moderate to high diurnal peaks in electron flux are probable in the coming days, however any further CME glancing blows may see the electrons suppressed once again, but this is considered low confidence.

The associated 24 hour fluence has shown a steady rising trend but remains below the Active threshold. A further rise is anticipated over the next 24 hours or so, but is currently considered to be unlikely to breach the Active threshold. REFM is currently giving reasonable overall guidance of the expected trend in the coming days, remaining below Active throughout.

GEO Electron Environment	Level (cm^{-2} sr^{-1} day^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability (Exceedance)			(%)	(%)	(%)	(%)
Active	≥ 2 MeV ≥ $1x10^8$	No	5	20	20	10
Very Active	≥ 2 MeV ≥ $1x10^9$	No	1	1	1	1

Figure 3: MOSWOC REFM output



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